EPA-230/1-74-039

ECONOMIC ANALYSIS OF PROPOSED EFFLUENT GUIDELINES

FOR

THE INORGANIC CHEMICALS INDUSTRY

September 1974

Contract No. 68-01-1541

Office of Planning and Evaluation

Environmental Protection Agency

Washington, D.C. 20460

PREFACE

The attached document is a contractor's study prepared for the Office of Planning and Evaluation of the Environmental Protection Agency ("EPA"). The purpose of the study is to analyze the economic impact which could result from the application of alternative effluent limitation guidelines and standards of performance to be established under sections 304(b) and 306 of the Federal Water Pollution Control Act, as amended.

The study supplements the technical study ("EPA Development Document") supporting the issuance of proposed regulations under sections 304(b) and 306. The Development Document surveys existing and potential waste treatment control methods and technology within particular industrial source categories and supports proposal of certain effluent limitation guidelines and standards of performance based upon an analysis of the feasibility of these guidelines and standards in accordance with the requirements of sections 304(b) and 306 of the Act. Presented in the Development Document are the investment and operating costs associated with various alternative control and treatment technologies. The attached document supplements this analysis by estimating the broader economic effects which might result from the required application of various control methods and technologies. This study investigates the effect of alternative approaches in terms of product price increases, effects upon employment and the continued viability of affected plants, effects upon foreign trade and other competitive effects.

The study has been prepared with the supervision and review of the Office of Planning and Evaluation of EPA. This report was submitted in fulfillment of Contract No. 68-01-1541, Task Order No. 29 by Arthur D. Little, Inc. Work was completed as of September 1974.

This report is being released and circulated at approximately the same time as publication in the Federal Register of a notice of proposed rule making under sections 304(b) and 306 of the Act for the subject point source category. The study is not an official EPA publication. It will be considered along with the information contained in the Development Document and any comments received by EPA on either document before or during proposed rule making proceedings necessary to establish final regulations. Prior to final promulgation of regulations, the accompanying study shall have standing in any EPA proceeding or court proceeding only to the extent that it represents the views of the contractor who studied the subject industry. It cannot be cited, referenced, or represented in any respect in any such proceeding as a statement of EPA's views regarding the subject industry.

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II. EXECUTIVE SUMMARY

A. INDUSTRY CHARACTERIZATION

While each of the inorganic chemicals covered in detail in this report is unique in certain characteristics, it is possible to point out some common characteristics of the group, citing some exceptions for those segments which do not conform to the generalization. For example, the segments are characterized by low physical volume, with annual production ranging between 17,000 and 300,000 tons. There are segments above this range (e.g , calcium hydroxide with annual production of 2.4 million tons and carbon dioxide with annual production of 1.5 million tons). On the low side, exceptions include potassium permanganate with 2,000 tons annual production, silver nitrate with 3,000 tons annual production and all of the chrome pigments (including iron blue) with the exception of chrome yellow.

The inorganic chemicals included in this study generally have a high unit value with 1972 plant prices ranging from $50 to $700 per ton. Exceptions on the low side include calcium hydroxide at approximately $18.00 per ton and carbon dioxide at approximately $28.00 per ton. Above the range are the chrome pigments with an average unit value of $900.00 per ton and silver nitrate with a unit value of $30,000 per ton. Since 1972, prices have increased (some as much as 20 to 30%).

For any individual segment there are relatively few plants -- typically 15 or less. Exceptions include calcium hydroxide with 65 producing facilities, carbon dioxide with 55 plants and lead monoxide with 24 plants. There are relatively few producers for any given segment, and generally one plant per producer. Exceptions to this generalization are calcium hydroxide and carbon dioxide.

Demand growth for these segments is low, usually 5% per year or less on a compound basis. Exceptions include aluminum fluoride at 7% per year, carbon dioxide at 9% per year, and carbon monoxide at 10% a year. In addition to these growing segments, the demand for sodium silicofluoride and sodium thiosulfate has recently been declining.

Foreign competition is low to moderate with the exception of sulfur dioxide where 1972 imports represented 30% of apparent U.S. consumption. In all cases exports are negligible.

As would be expected for commodity materials, the primary basis for competition is price. Profitability is modest, generally 5% return on sales after taxes.

In general, production facilities are old (plant ages range from 10 to 30 years) with relatively few new plants having been constructed recently. In summary, these characteristics are typical for products in a mature stage of their life cycle.

B. POLLUTION CONTROL COSTS

Pollution control cost data were obtained from a draft report by General Technologies Corporation, completed for EPA in December 1973 and entitled Development Document for Proposed Effluent Limitations Guidelines and New Source Performance Standards for the Inorganic Chemicals Industry (Phase II), and additional cost information which was prepared by the Effluent Guidelines Division of EPA. The water treatment costs (on a before-tax basis) categorized by in-depth study products and prescreening study products are shown in Table 1. In this table, the treatment costs from the Development Document have been converted to a dollars per short ton basis.

In Table 2 are shown the total investment costs for treatment facilities to achieve B.P.T and B.A.T. standards for the in-depth study products and the prescreening study products. The treatment facilities capital investment estimates were taken from the Development Document and exclude the capital investments for treatment in place. The capital investment indicated for B.A.T. includes the investment for B.P.T. As indicated in the table, the total incremental investment cost for the in-depth study products is $8.79 million for B P.T and $22.52 million for B.A.T. Similarly, the total investment cost for the prescreening study products is $4.22 million for B.P.T. and $4.29 million for B.A.T.

Table 2 also compares the investment in treatment facilities for each of the products with the estimated annual capital expenditures for the group. The total expenditures for plant and equipment for 1972 for the inorganic chemicals covered by this report ($87.4 million) was determined by prorating their dollar value of shipments with the aggregate capital expenditures in 1972 for the appropriate Standard Industrial Classification categories (SIC 2813, SIC 2816, SIC 2819, and SIC 2873). Total capital expenditures and value of shipments for the SIC categories were taken from the 1972 Census of Manufactures. As indicated in Table 2, total treatment facilities investment for the in-depth study products for B.P.T. represents 10.06% of the estimated 1972 capital expenditures and 25.77% for B.A.T. Similarly, the B.P.T. expenditure for the prescreening study products represents 4.84% of the 1972 capital expenditures while B.A.T. represents 4.91%.

The total annual cost for B.P.T. and B.A.T. treatment for both the in-depth study products and the prescreening study products is shown in Table 2a. This table also compares the annual cost of B.P.T. and B.A.T. treatment with the 1972 selling price for each product.

TABLE 1

WATER TREATMENT COSTS BY LEVELS OF CONTROL
(Dollars Per Ton of Product)

In-Depth Study Products	Best Practicable Technology	Best Available Technology
Aluminum Fluoride	2.27	3.40
Barium Carbonate[1]	3.72	5.99
Boric Acid	0.83	0.83
Calcium Carbonate (Precipitated)	1.04	2.87
Calcium Hydroxide	0.00	0.00
Carbon Dioxide	0.13	0.80
Carbon Monoxide and Hydrogen	0.14	4.98
Chrome Pigments	18.00	18.63
Copper Sulfate[2]	0.63	2.07
Ferric Chloride	2.25	2.25
Hydrogen Cyanide[3]	4.17	4.17
Lead Monoxide	2.19	2.19
Manganese Sulfate	4.65	30.26
Nickel Sulfate	1.71[4]	17.91
Potassium Permanganate	0.05	27.33
Silver Nitrate	<0.01[5]	<0.01[5]
Sodium Bisulfite	3.97	4.46
Sodium Hydrosulfide	2.47	12.42
Sodium Hydrosulfite	1.09	5.62
Sodium Silicofluoride	0.00	4.61
Sodium Thiosulfate	4.31	8.10
Sulfur Dioxide	4.57	5.18
Zinc Oxide	0.00	2.50

[1]For production accounting for 30% of the industry, B.P.T. costs are zero and B.A.T. costs are $2.00.

[2]Costs for "waste recovery" process; for the alternate production route based on scrap copper, B.P.T. and B.A.T. treatment costs are $0.15.

[3]Costs for an alternate treatment approach are $14.00 for both B.P.T. and B.A.T.

[4]Costs for large facility located in a complex; comparable B.P.T. costs for large facility not in a complex are $2.49 and for a small facility are $45.61.

[5]Figures for Silver Nitrate are reported in Av. ounces.

TABLE 1 (Continued)

WATER TREATMENT COSTS BY LEVELS OF CONTROL
(Dollars Per Ton of Product)

	Best Practicable Technology	Best Available Technology
Prescreening Study Products		
Ammonium Chloride	0.00	1.90
Ammonium Hydroxide	0.08	0.08
Borax	0.00	0.00
Bromine	0.75	0.75
Chromic Acid	0.00	0.00
Cuprous Oxide	1.90	1.90
Ferrous Sulfate	0.00	0.00
Fluorine	18.68	19.19
Hydrogen	0.00	0.00
Iodine	0.74	0.74
Lithium Carbonate	0.00	1.20
Nitric Acid (Strong)[1]	0.36	0.67
Oxygen	0.03	0.03
Nitrogen	0.03	0.03
Potassium Chloride	0.00	0.00
Potassium Iodide[2]	2.79	0.00
Sodium Fluoride[4]	0.00	0.00
Stannic Oxide	111.84	0.00
Trona	0.00	0.00
Zinc Sulfate[3]	0.68	0.68

[1] For production accounting for 15% of the industry, B.P.T. costs are $0.63 and B.A.T. costs are $1.00.

[2] For production accounting for 33% of the industry, B.P.T. and B.A.T. costs are zero.

[3] For production accounting for 67% of the industry, B.P.T. and B.A.T. costs are zero.

[4] For production by the anhydrous neutralization process, costs for the silicofluoride process are $0.24 per ton for both B.P.T. and B.A.T.

TABLE 2

TOTAL INVESTMENT COST FOR EFFLUENT GUIDELINES AND AS A PERCENT OF ESTIMATED 1972 ANNUAL CAPITAL EXPENDITURES*

	Number of Plants	Total Investment Cost B.P.T. ($ MM)	Total Investment Cost B.A.T. ($ MM)	Water Treatment Investment as Percent of 1972 Capital Expenditures B.P.T. (%)	Water Treatment Investment as Percent of 1972 Capital Expenditures B.A.T. (%)
In-Depth Study Products					
Aluminum Fluoride	6	0.31	0.88	0.35	1.01
Barium Carbonate	3	0.10	0.24	0.11	0.27
Boric Acid	4	0.11	0.11	0.13	0.13
Calcium Carbonate (Precipitated)	7	0.18	0.98	0.21	1.12
Calcium Hydroxide	65	0.00	0.00	0.00	0.00
Carbon Dioxide	55	0.89	3.29	1.02	3.77
Carbon Monoxide	13	0.08	2.91	0.09	3.33
Chrome Pigments	12	3.51	3.75	4.02	4.29
Copper Sulfate	10	0.01	0.11	0.02	0.13
Ferric Chloride	7	0.05	0.05	0.06	0.06
Hydrogen Cyanide	10	0.87	0.87	1.00	1.00
Lead Monoxide	24	1.03	1.03	1.18	1.18
Manganese Sulfate	3	0.04	2.24	0.05	2.56
Nickel Sulfate	4	0.12	0.47	0.14	0.54
Potassium Permanganate	1	<0.01	0.12	<0.01	0.14
Silver Nitrate	3	0.00	0.63	0.00	0.72
Sodium Bisulfite	5	0.22	0.23	0.25	0.26
Sodium Hydrosulfide	8	0.31	0.63	0.35	0.72
Sodium Hydrosulfite	7	0.07	0.63	0.08	0.72
Sodium Silicofluoride	5	0.00	0.28	0.00	0.32
Sodium Thiosulfate	5	0.22	0.43	0.25	0.49
Sulfur Dioxide	7	0.65	0.78	0.74	0.89
Zinc Oxide	6	0.00	1.86	0.00	2.13
Total		8.79	22.52	10.06	25.77
Prescreening Study Products					
Ammonium Chloride	5	0.00	0.10	0.00	0.11
Ammonium Hydroxide	NA	0.01	0.01	0.01	0.01
Borax	7	0.00	0.00	0.00	0.00
Bromine	10	0.08	0.08	0.09	0.09
Chromic Acid	4	0.00	0.00	0.00	0.00
Cuprous Oxide	25	<0.01	<0.01	<0.01	<0.01
Ferrous Sulfate	13	0.00	0.00	0.00	0.00
Fluorine	2	0.76	0.77	0.88	0.89
Hydrogen	153	0.00	0.00	0.00	0.00
Iodine	3	<0.01	<0.01	<0.01	<0.01
Lithium Carbonate	4	0.00	0.10	0.00	0.12
Nitric Acid (Strong)	5	0.11	0.11	0.13	0.13
Oxygen	215	2.09	2.09	2.39	2.39
Nitrogen	202	0.95	0.95	1.09	1.09
Potassium Chloride	14	0.00	0.00	0.00	0.00
Potassium Iodide	10	<0.01	0.00	0.01	0.00
Sodium Fluoride	5	0.00	0.00	0.00	0.00
Stannic Oxide	5	0.14	0.00	0.16	0.00
Trona		0.00	0.00	0.00	0.00
Zinc Sulfate	17	0.06	0.06	0.07	0.07
Total		4.22	4.29	4.84	4.91

*1972 capital expenditures for the inorganic chemicals (Phase II) were assumed to occur in proportion to their dollar volume share of total shipments for the appropriate SIC categories. Thus, 1972 capital expenditures were assumed to be 67.5% of total SIC 2813, 17.3% of SIC 2816, 17.4% of SIC 2819, and 4.7% of 2873 for an aggregate $87.4 million.

TABLE 2a

ANNUAL COST FOR EFFLUENT CONTROL AND AS A PERCENT OF 1972 SELLING PRICE

	Total Annual Cost		Annual Cost as Percent of 1972 Selling Price	
	B.P.T. ($ MM)	B.A.T. ($ MM)	B.P.T. (%)	B.A.T. (%)
In-Depth Study Products				
Aluminum Fluoride	0.32	0.47	0.86	1.29
Barium Carbonate	0.04	0.09	3.03	4.88
Boric Acid	0.10	0.10	0.79	0.79
Calcium Carbonate (Precipitated)	0.23	0.63	1.70	4.65
Calcium Hydroxide	0.00	0.00	0.00	0.00
Carbon Dioxide	0.19	1.18	0.44	2.79
Carbon Monoxide	0.04	1.52	0.11	4.02
Chrome Pigments	1.19	1.23	2.00	2.07
Copper Sulfate	0.01	0.04	0.15	0.48
Ferric Chloride	0.17	0.17	2.88	2.88
Hydrogen Cyanide	0.81	0.81	1.81	1.81
Lead Monoxide	0.31	0.31	0.65	0.65
Manganese Sulfate	0.15	0.96	5.02	32.64
Nickel Sulfate	0.11	0.30	0.23	2.40
Potassium Permanganate	<0.01	0.05	0.01	3.59
Silver Nitrate	0.00	0.23	0.01	0.27
Sodium Bisulfite	0.17	0.19	2.84	3.18
Sodium Hydrosulfide	0.06	0.31	2.30	11.57
Sodium Hydrosulfite	0.05	0.26	0.24	1.26
Sodium Silicofluoride	0.00	0.26	0.01	3.95
Sodium Thiosulfate	0.09	0.18	3.83	7.18
Sulfur Dioxide	0.46	0.52	8.22	9.31
Zinc Oxide	0.00	0.60	0.00	0.68
	$4.50	$10.41		
Prescreening Study Products				
Ammonium Chloride	0.00	0.03	0.00	1.46
Ammonium Hydroxide	<0.01	<0.01	0.10	0.10
Borax	0.00	0.00	0.00	0.00
Bromine	0.03	0.03	0.27	0.27
Chromic Acid	0.00	0.00	0.00	0.00
Cuprous Oxide	<0.01	<0.01	0.18	0.18
Ferrous Sulfate	0.00	0.00	0.00	0.00
Fluorine	0.19	0.19	0.06	0.06
Hydrogen	0.00	0.00	0.00	0.00
Iodine	<0.01	<0.01	0.02	0.02
Lithium Carbonate	0.00	0.02	0.00	0.11
Nitric Acid (Strong)	0.08	0.14	0.04	0.08
Oxygen	0.47	0.47	0.18	0.18
Nitrogen	0.21	0.21	0.16	0.16
Potassium Chloride	0.00	0.00	0.00	0.00
Potassium Iodide	<0.01	0.00	0.04	0.00
Sodium Fluoride	0.00	0.00	0.00	0.00
Stannic Oxide	0.05	0.00	2.74	0.00
Trona	0.00	0.00	0.00	0.00
Zinc Sulfate	0.01	0.01	0.46	0.46
	$1.04	$1.10		

C. IMPACT ANALYSIS

We have used the factors summarized in Table 3 for each of the in-depth study segments to make our judgment of the potential economic impact of proposed effluent guidelines. In most cases, we believe that the water treatment costs can be passed on to the consumer through price increases ranging from 0 to 6.1% for 1977 and from 0 to 32.6% in 1983. However, in two segments--sulfur dioxide and ferric chloride--competitive conditions will not allow price increases and as a result producers will have to absorb the water treatment costs at the expense of profit margins. In a third segment, nickel sulfate, the price increase anticipated will probably not be sufficient to cover the full cost of abatement for all producers. As a result, it is estimated that one to two plants in the sulfur dioxide segment and one plant in the nickel sulfate segment will close.

The sulfur dioxide plants represent less than 15% (approximately 12 to 13%) of the segment's total productive capacity. However, since excess capacity currently exists in this industry, there should be no supply shortages as a result of these closures. The sulfur dioxide plants which are threatened with closure employ from 15 to 30 people, depending upon whether one or both plants are closed. Since these plants are owned by relatively large chemical companies, the affected employees should have opportunities for reemployment in the company--either locally or at other sites.

A shutdown decision is anticipated in 1977 for one nickel sulfate plant. This plant produces approximately 2 000 tons per year of nickel sulfate and represents about 10% of productive capacity in the industry segment. Although capacity utilization is currently high for the segment, it is expected that the larger producers can make up the lost production. Approximately 15 to 20 people are employed by the one nickel sulfate plant. The company should be able to reemploy these people, particularly if, as expected, the nickel sulfate facilities are converted to production of other products.

Producers of ferric chloride by the iron-chlorine process will be unable to increase prices to cover the cost of pollution control due to strong price competition from producers with lower cost manufacturing processes. Ferric chloride produced by the iron-chlorine process currently competes at a manufacturing cost disadvantage with ferric chloride recovered from steel pickling liquors. Furthermore, processes are being developed to recover ferric chloride from the effluent of chloride process titanium dioxide plants. It is anticipated that the supply of ferric chloride will increase significantly when this new recovery process capacity comes on-stream. As a result of these anticipated increased supplies, ferric chloride prices may actually decline. Under these conditions, it is anticipated that two ferric chloride plants will close. However, these closures are considered to be baseline closures since they would probably occur even if there were no new water treatment costs

TABLE 3

IMPACT ANALYSIS MATRIX

			ALUMINUM FLUORIDE	BARIUM CARBONATE	BORIC ACID	CALCIUM CARBONATE
1972 Production (M Tons)			138.8	44.6	121.4	220.9
1972 Unit Value ($/Ton)			264.08	122.70 (1971)	104.25	61.58
1972 Production Value ($MM)			36.7	5.9	12.7	13.6
Number of Plants (Current)			6	3	4	7
Estimated Employment (Total Employees)			615	100	215	225
PRICE INCREASE CONSTRAINTS						
Factor	Condition for Constraint	Treatment Level				
Ratio of BT* Treatment Cost to Selling Price (%)	High	B.P.T. B.A.T.	0.9 1.3	3.0 4.9**	0.8 0.8	1.7 4.6
Substitute Products	High Occurrence		Low	Medium	Moderate	High
Capacity Utilization	Low		78%	High	Approximately 90%	60-70%
Captive Usage	Low		64%	Negligible	20-30%	Low
Demand Growth	Low		7% Per Year	Static	Low	Moderate
Foreign Competition	High		Low	Low	Low	Low
Abatement Cost Differences	Unequal		Equal	Unequal	Unequal	Equal
Price Elasticity of Demand	High		Low	Medium	Moderate	Moderate
Basis for Competition	Price		Price	Price	Price	Price and Properties
Market Share Distribution	Fragmented		Concentrated	Concentrated	Concentrated	Relatively Fragmented
Number of Producers	Many		4	3	3	6

*Before-Tax.
**For production accounting for 30% of the industry, B.P.T. costs are zero and B.A.T costs represent 1.6% of the 1971 selling price.

TABLE 3 (Continued)

IMPACT ANALYSIS MATRIX

PLANT SHUTDOWN DECISION			ALUMINUM FLUORIDE	BARIUM CARBONATE	BORIC ACID	CALCIUM CARBONATE
Factor	Condition for Shutdown	Treatment Level				
Ratio of AT* Treatment Cost to AT Net Income (%)	High	B.P.T. B.A.T.	46.8 70.1	39.9 64.2**	18.2 18.2	21.5 58.5
Cash Flow (Including Treatment Costs)	Negative		Positive	Positive	Positive	Positive
Ratio of Investment in Treatment Facilities to Net Fixed Investment (%)	High	B.P.T. B.A.T.	29.6 54.4	34.0 56.2***	1.8 1.8	2.5 10.1
Integration	Low		High	High	Moderate	High Backward; Low Forward
Chemical Complex	Isolated Plant		Complex	Complex	Complex	Some Isolated; Some Complex
Other Environmental Problems (Including OSHA)	Multiple		Nominal	Air Pollution	None	None
Emotional Commitment	Indifference		High	Considerable	High	Relative Indifference
Ownership	Multi-Industry Companies		Multi-Industry	2 Multi-Industry; 1 Narrow Product Line	Multi-Industry	Multi-Industry

*After-Tax.
**For production accounting for 30% of the industry, B.P.T. costs are zero and B.A.T. costs represent 21.5% of after-tax net income.
***For production accounting for 30% of the industry, B.A.T. investment represents 21.5% of net fixed investment.

TABLE 3 (Continued)

IMPACT ANALYSIS MATRIX

			CALCIUM HYDROXIDE	CARBON DIOXIDE	CARBON MONOXIDE	CHROME PIGMENTS
1972 Production (M Tons)			2,404	1,481	305	66.0 est.
1972 Unit Value ($/Ton)			17.85	28.59	124	904
1972 Production Value ($MM)			42.9	42.3	37.8	60
Number of Plants (Current)			65	55	13	12
Estimated Employment (Total Employees)			715	700	630	600
PRICE INCREASE CONSTRAINTS						
Factor	Condition for Constraint	Treatment Level				
Ratio of BT Treatment Cost to Selling Price (%)	High	B.P.T. B.A.T.	0 0	0.4 2.8	0.1 4.0	2.0 2.1
Substitute Products	High Occurrence		Moderate to High	Low	Few, If Any	Moderate
Capacity Utilization	Low		High	90% (Seasonally Adjusted)	80%+	Moderate
Captive Usage	Low		Low	10%	65%	Low
Demand Growth	Low		Low	9% Per Year	10% Per Year	Low
Foreign Competition	High		Low	Low	Low	Moderate
Abatement Cost Differences	Unequal		Unequal*	Equal	Equal	Equal
Price Elasticity of Demand	High		Moderate to High	Low	Low	Low to Moderate
Basis for Competition	Price		Price, Availability, Some Properties	Price	Price	Price
Market Share Distribution	Fragmented		Fragmented	Concentrated	Concentrated	Fragmented
Number of Producers	Many		45	11	12	11

*Although there are no abatement costs resulting directly from Calcium Hydroxide production, there are unequal treatment costs for associated lime production.

TABLE 3 (Continued)

IMPACT ANALYSIS MATRIX

PLANT SHUTDOWN DECISION			CALCIUM HYDROXIDE	CARBON DIOXIDE	CARBON MONOXIDE	CHROME PIGMENTS
Factor	Condition for Shutdown	Treatment Level				
Ratio of AT Treatment Cost to AT Net Income (%)	High	B.P.T. B.A.T.	0 0	5.3 33.3	1.2 39.9	18.1 18.8
Cash Flow (Including Treatment Costs)	Negative		Positive	Positive	Positive	Positive
Ratio of Investment in Treatment Facilities to Net Fixed Investment (%)	High	B.P.T. B.A.T.	0 0	4.0 13.8	5.6 82.0	78.6 79.5
Integration	Low		High Backward; Low Forward	Low	High Forward	No Backward; Low Forward
Chemical Complex	Isolated Plant		Isolated	Isolated	Complex	Isolated
Other Environmental Problems (Including OSHA)	Multiple		Air Pollution	None	None	OSHA
Emotional Commitment	Indifference		High	Indifference	High	Committed
Ownership	Multi-Industry Companies		Multi-Industry	Multi-Industry	Multi-Industry	Mixed

TABLE 3 (Continued)

IMPACT ANALYSIS MATRIX

			COPPER SULFATE	FERRIC CHLORIDE	HYDROGEN CYANIDE	LEAD MONOXIDE
1972 Production (M Tons)			34.7	76.7	135.8	139.8
1972 Unit Value ($/Ton)			426.53 (1971)	78.37	230 (List)	333.06
1972 Production Value ($MM)			14.8	6.0	54.2	46.6
Number of Plants (Current)			10	7	10	24
Estimated Employment (Total Employees)			115	100	900	750
PRICE INCREASE CONSTRAINTS						
Factor	Condition for Constraint	Treatment Level				
Ratio of BT Treatment Cost to Selling Price (%)	High	B.P.T.	0.2**	2.9	1.8*	0.6
		B.A.T.	0.5**	2.9	1.8*	0.6
Substitute Products	High Occurrence		High	High	Low	Low
Capacity Utilization	Low		Adjustable to Demand	Low	73%	High
Captive Usage	Low		0%	Low	80%	Low
Demand Growth	Low		Static	High	Low	4% Per Year
Foreign Competition	High		Low	None	Low	Low
Abatement Cost Differences	Unequal		Unequal (But Difference is Small)	Unequal	Unequal	Equal
Price Elasticity of Demand	High		High	High	Low	Low
Basis for Competition	Price		Price	Price	Price and Service	Price
Market Share Distribution	Fragmented		Concentrated	Fragmented	Concentrated	Concentrated
Number of Producers	Many		9	7	7	6

*Ratio for an alternate treatment approach is 6.1% for both B.P.T. and B.A.T.

**Ratios for "waste recovery" process; for the alternate production route based on scrap copper, B.P.T. and B.A.T. treatment costs represent 0.03% of the 1971 plant price.

TABLE 3 (Continued)

IMPACT ANALYSIS MATRIX

PLANT SHUTDOWN DECISION			COPPER SULFATE	FERRIC CHLORIDE	HYDROGEN CYANIDE	LEAD MONOXIDE
Factor	Condition for Shutdown	Treatment Level				
Ratio of AT Treatment Cost to AT Net Income (%)	High	B.P.T. B.A.T.	6.3*** 20.7***	48.1 48.1	18.1* 18.1*	26.3 26.3
Cash Flow (Including Treatment Costs)	Negative		Positive	Positive	Positive	Positive
Ratio of Investment in Treatment Facilities to Net Fixed Investment (%)	High	B.P.T. B.A.T.	0.9**** 9.6****	2.9 2.9	9.6** 9.6**	44.3 44.3
Integration	Low		High Backward; Low Forward	Low	Moderate Backward; High Forward	Low Forward; High Backward
Chemical Complex	Isolated Plant		Complex	Complex/Isolated	Complex	Complex
Other Environmental Problems (Including OSHA)	Multiple		None	Minimal	Air and OSHA	OSHA
Emotional Commitment	Indifference		Indifference	Mixed	Moderate to High	Relative Indifference
Ownership	Multi-Industry Companies		Multi-Industry	Multi-Industry	Multi-Industry	Multi-Industry

*Ratio for an alternate treatment approach is 53.0% for both B.P.T. and B.A.T.

**Ratio for an alternate treatment approach is 34.5% for both B.P.T. and B.A.T

***Ratios for waste recovery process; after-tax treatment costs for production based on scrap copper represents 1.4% of after-tax margins for both B.P.T. and B.A.T.

****Ratios for waste recovery process; treatment facilities investment for production based on scrap copper represents 1.1% of estimated net fixed investment (book basis) for both B.P.T. and B A.T.

TABLE 3 (Continued)

IMPACT ANALYSIS MATRIX

			MANGANESE SULFATE	NICKEL SULFATE	POTASSIUM PERMANGANATE	SILVER NITRATE
1972 Production (M Tons)			31.6	16.8 (1971)	NA	99.9***
1972 Unit Value ($/Ton)			92.68	681.07 (1971)	760 (List)	0.91*
1972 Production Value ($MM)			2.93	11.4 (1971)	NA	90.9
Number of Plants (Current)			3	4	1	3
Estimated Employment (Total Employees)			50	125	NA	NA
PRICE INCREASE CONSTRAINTS						
Factor	Condition for Constraint	Treatment Level				
Ratio of BT Treatment Cost to Selling Price (%)	High	B.P.T. B.A.T.	5.0 32.6	0.3** 2.4	0.01 3.6	0.01 0.27
Substitute Products	High Occurrence		Moderate	Moderate to High	Medium	Low
Capacity Utilization	Low		50%	High	High	High
Captive Usage	Low		Low	9.4%	Low	High
Demand Growth	Low		Static	Low	Growing	High
Foreign Competition	High		Low	Low	Low	Low
Abatement Cost Differences	Unequal		Unequal	Unequal	Not Applicable	Equal
Price Elasticity of Demand	High		Low	Moderate	Low	Low
Basis for Competition	Price		Price	Price	Price and Service	Availability
Market Share Distribution	Fragmented		Concentrated	Concentrated	Concentrated	Concentrated
Number of Producers	Many		3	4	1	3

*Dollars per av. ounce, list price.
**Ratio for large facility not located in a complex; comparable ratio for large facility in a complex is 0.2% and for small facility, 6.1%.
***Millions of av. ounces.

TABLE 3 (Continued)

IMPACT ANALYSIS MATRIX

PLANT SHUTDOWN DECISION						
Factor	Condition for Shutdown	Treatment Level	MANGANESE SULFATE	NICKEL SULFATE	POTASSIUM PERMANGANATE	SILVER NITRATE
Ratio of AT Treatment Cost to AT Net Income (%)	High	B.P.T. B.A.T.	26.5 172.7	3.4* 24.1	NA NA	0.6 12.2
Cash Flow (Including Treatment Costs)	Negative		Negative (B.A.T.)	Positive	Positive	Positive
Ratio of Investment in Treatment Facilities to Net Fixed Investment (%)	High	B.P.T. B.A.T.	42.2 345.0	2.0** 13.3	NA NA	1.5 31.1
Integration	Low		High	Low	Low	High
Chemical Complex	Isolated Plant		Complex	Complex and Isolated	Isolated Plant	Complex
Other Environmental Problems (Including OSHA)	Multiple		None	Air Pollution	Nominal	None
Emotional Commitment	Indifference		Committed	Large Committed; Small Indifference	High	Committed
Ownership	Multi-Industry Companies		Multi-Industry	Multi-Industry	Family-Owned	Multi-Industry

*Ratio for large facility not located in a complex; comparable ratio for large facility in a complex is 2.3% and for small isolated facility, 61.3%
**Ratio for large facility not located in a complex; comparable ratio for large facility in a complex is 0.7% and for small isolated facility, 28.2%.

TABLE 3 (Continued)

IMPACT ANALYSIS MATRIX

			SODIUM BISULFITE	SODIUM HYDROSULFIDE	SODIUM HYDROSULFITE	SODIUM SILICOFLUORIDE
1972 Production (M Tons)			42.5	25.2	46.7	57.4
1972 Unit Value ($/Ton)			140.0 (est)	107.25	446.02	116.67
1972 Production Value ($MM)			6.0	2.7	20.9	6.7
Number of Plants (Current)			5	8	7	5
Estimated Employment (Total Employees)			100	45	350	110
PRICE INCREASE CONSTRAINTS						
Factor	Condition for Constraint	Treatment Level				
Ratio of BT Treatment Cost to Selling Price (%)	High	B.P.T. B.A.T.	2.8 3.2	2.3 11.6	0.2 1.3	0 4.0
Substitute Products	High Occurrence		Few	Moderate to High	Moderate	Medium
Capacity Utilization	Low		85%	48%	High	High
Captive Usage	Low		Low	10%	None	45%
Demand Growth	Low		5% Per Year	Static	Moderate	Static to Declining
Foreign Competition	High		Low	Low	Low	Low to Moderate
Abatement Cost Differences	Unequal		Equal	Equal*	Equal	Equal
Price Elasticity of Demand	High		Low	Moderately High	Fairly Low	Low to Medium
Basis for Competition	Price		Price	Price	Price, Quality	Price
Market Share Distribution	Fragmented		Concentrated	Concentrated	Concentrated	Fragmented
Number of Producers	Many		2	6	5	6

*Equal abatement costs for direct dischargers. It can be assumed that pretreatment standards and, thus, costs will be approximately equal to B.P.T. for the one producer in a municipal system. However, it can also be presumed that this producer will not face additional costs similar to B.A.T. costs for 1983.

TABLE 3 (Continued)

IMPACT ANALYSIS MATRIX

PLANT SHUTDOWN DECISION						
Factor	Condition for Shutdown	Treatment Level	SODIUM BISULFITE	SODIUM HYDROSULFIDE	SODIUM HYDROSULFITE	SODIUM SILICOFLUORIDE
Ratio of AT Treatment Cost to AT Net Income (%)	High	B.P.T. B.A.T.	24.9 27.9	17.4 87.4	2.7 14.0	0 31.2
Cash Flow (Including Treatment Costs)	Negative		Positive	Positive	Positive	Positive
Ratio of Investment in Treatment Facilities to Net Fixed Investment (%)	High	B.P.T. B.A.T.	23.7 24 1	33.7 67.9	4.1 16.6	0 35.5
Integration	Low		High Backward; Low Forward	Low	High Backward; Low Forward	High Backward; Medium Forward
Chemical Complex	Isolated Plant		Complex	Complex	Complex	Complex
Other Environmental Problems (Including OSHA)	Multiple		None	Nominal	Few	None
Emotional Commitment	Indifference		Committed	Indifference	Fairly High	Moderate
Ownership	Multi-Industry Companies		Multi-Industry	Multi-Industry	Mixed	Multi-Industry

TABLE 3 (Continued)

IMPACT ANALYSIS MATRIX

			SODIUM THIOSULFATE	SULFUR DIOXIDE	ZINC OXIDE	
1972 Production (M Tons)			21.6	100.2	238.4	
1972 Unit Value ($/Ton)			112.68	55.65	365	
1972 Production Value ($MM)			2.4	5.6	85	
Number of Plants (Current)			5	7	6	
Estimated Employment (Total Employees)			40	90	NA	
PRICE INCREASE CONSTRAINTS						
Factor	Condition for Constraint	Treatment Level				
Ratio of BT Treatment Cost to Selling Price (%)	High	B.P.T. B.A.T.	3.8 7.2	8.2 9.3	0 0.7	
Substitute Products	High Occurrence		High	Moderate	High	
Capacity Utilization	Low		Moderate; Decreasing	Low	High	
Captive Usage	Low		Low	Low	Low	
Demand Growth	Low		Declining	Low	Moderate	
Foreign Competition	High		Low	High	Low	
Abatement Cost Differences	Unequal		Equal	Unequal	Unequal	
Price Elasticity of Demand	High		High	Moderate	Low	
Basis for Competition	Price		Price	Price	Price and Quality	
Market Share Distribution	Fragmented		Concentrated	Concentrated	Fairly Concentrated	
Number of Producers	Many		3	7	5	

TABLE 3 (Continued)

IMPACT ANALYSIS MATRIX

PLANT SHUTDOWN DECISION						
Factor	Condition for Shutdown	Treatment Level	SODIUM THIOSULFATE	SULFUR DIOXIDE	ZINC OXIDE	
Ratio of AT Treatment Cost to AT Net Income (%)	High	B.P.T. B.A.T.	33.7 63.7	51.1 64.9	NA NA	
Cash Flow (Including Treatment Costs)	Negative		Positive	Positive	Positive	
Ratio of Investment in Treatment Facilities to Net Fixed Investment (%)	High	B.P.T. B.A.T.	73.7 119.7	69.6 78.8	NA NA	
Integration	Low		High Backward; Low Forward	Low	High Forward	
Chemical Complex	Isolated Plant		Complex	Chemical Complex	Complex	
Other Environmental Problems (Including OSHA)	Multiple		Nominal	None	Low	
Emotional Commitment	Indifference		Indifference	Indifference	Moderate	
Ownership	Multi-Industry Companies		Multi-Industry	Multi-Industry	Multi-Industry	

for ferric chloride. Although the two affected plants represent approximately 50% of current productive capacity, that capacity will be replaced with the new recovery process plants. Approximately 50 to 75 people are employed by the ferric chloride plants which are expected to close. Since these plants are part of large chemical complexes, some of the dislocated employees will probably be reemployed within the companies. Others should be able to obtain employment locally since the affected plants are located in highly industrialized areas.

Because the number of dislocated employees for each of the affected plants are low and opportunities for reemployment exist, only minimal community impacts are expected as a result of the projected sulfur dioxide, nickel sulfate, and ferric chloride plant closures. Similarly, balance of trade effects are expected to be minimal for both ferric chloride and nickel sulfate since imports and exports are negligible. Although approximately 30% of apparent U.S. consumption of sulfur dioxide was imported in 1972, current excess capacity in the domestic industry is expected to replace the loss of capacity resulting from sulfur dioxide plant closures. Domestic capacity has been expanded recently by the installation of facilities for removal of sulfur dioxide from the stack gases of sulfide ore smelting plants. This capacity expansion has changed the U.S. supply/demand balance from one for which capacity was less than demand, requiring major imports from Canada, to one where domestic capacity exceeds demand.

Because the magnitude of the price increases necessary to cover water treatment control costs are relatively low, there should be only minimal impact on industry growth for each of these segments.

III. IMPACT ANALYSIS METHODOLOGY

A relatively simple approach was used for the prescreening analysis. Specifically, water treatment costs per ton for both B.P.T. and B.A.T. were compared with unit selling prices. In addition, the total investment required for treatment facilities for the industry segment was determined. We also took into consideration the extent to which producers in each segment had already achieved B.P.T. and/or B.A.T. standards. On this basis, we eliminated some segments from in-depth consideration.

In order to assess the impact of water treatment costs on the remaining inorganic chemicals covered in this report, we have developed an analytical framework to arrive at the impact judgment. In addition to providing us with a systematic method to weigh each of the factors affecting the impact judgment, the methodology also provides a format by which the basis for our conclusions are clearly presented.

The basic premise behind the methodology is that a producer faced with new investment in water treatment facilities could (1) continue to operate by (a) passing on the additional costs through price increases, or (b) absorbing the costs (thereby reducing profits); or (2) shut his plant down.

The approach we have taken in assessing the impact on each of the inorganic chemicals is to first examine the likelihood that the higher costs imposed on the industry by virtue of new water effluent guidelines will be defrayed, wholly or in part, by higher product prices. If the conclusion is that treatment costs cannot be passed on through price increases, the second part of the impact analysis is to examine the likelihood that some plants in the industry would be forced to shut down, taking into account both economic and non-economic factors.

A. PRICE INCREASE CONSTRAINTS

The treatment costs per ton before taxes indicate the magnitude of the unit price increase necessary to fully recover all treatment costs (i.e., repay the investment and cover operating costs). The larger the ratio of before-tax unit treatment cost to actual unit selling price, the more difficult it will be to fully recover treatment costs, all things being equal. As indicated, the first question we have addressed is whether conditions in the specific competitive situation would permit price increases. In general, the products' price history and the nature of those prices--whether firm or widely dispersed and discounted--provide a clue as to the possibility of price increases. More specifically, however, the following factors are those that we have used in arriving at the judgment as to whether price increases are feasible. Except in unusual circumstances, no one factor would be overriding. Rather, the judgment is based on a combination of factors.

Substitute Products (or Processes)--If substitute products exist, price increases to cover the (full) costs of water treatment would be difficult.

Capacity Utilization--If capacity utilization for the industry is low, price increases to cover the (full) costs of treatment would be difficult.

Captive Usage--If there is negligible captive use, price increases to cover the (full) costs of water treatment would be difficult.

Why? Demand Growth--Price increases are more difficult to achieve in a static or declining market than in a growing market.

Foreign Competition--If the market can be served by foreign competitors (particularly if the foreign producers are not faced with added water pollution abatement costs), price increases are less likely.

Abatement Cost Differences--If some plants in the industry will incur substantially higher water pollution abatement expenditures than other plants, they will be less able to pass on the added costs as price increases, particularly if they compete in the same markets.

Price Elasticity of Demand--For some products, substantial water pollution abatement costs, if passed on as price increases, could result in reduced demand for the product.

Basis for Competition--If the basis for competition in the industry is primarily price as opposed to service or technology, cost increases will be more difficult to pass on, particularly if there is a significant difference between unit treatment costs between large producers and small producers.

Market Share Distribution--If the market share distribution is fragmented (rather than concentrated, in which case there often is a dominant price leader), price increases are less likely, particularly if treatment costs do not affect all producers fairly equally.

Number of Producers--If the market is served by many producers (increasing the likelihood of manufacturing cost differences, abatement cost differences, etc.), a condition exists constraining price increases.

Although not explicitly listed in the generic model, we have been alert to other factors which might prevail for individual products. For example, the economic importance of a product in the manufacturing costs of derivative products might act as a constraint on price increases.

I. INTRODUCTION

The following report is submitted in compliance with Task Order No. 29 to BOA No. 68-01-1541, "Economic Analysis of Proposed Effluent Limitations on the Inorganic Chemicals Industry" (Phase II). The purpose of this study is to provide the Environmental Protection Agency with an analysis of the economic impact of the cost of pollution abatement requirements under the Federal Water Pollution Control Amendment of 1972 on certain segments of the inorganic chemicals industry as contained in SIC 2813, SIC 2816, SIC 2819 and SIC 2873.

In performing this study of the inorganic chemicals industry, the following segments were studied in detail:

- aluminum fluoride
- barium carbonate
- boric acid
- calcium carbonate
- calcium hydroxide
- carbon dioxide
- carbon monoxide
- chrome green
- chrome yellow and orange
- chromic oxide green
- copper sulfate
- ferric chloride
- hydrogen cyanide
- iron blues
- lead monoxide
- manganese sulfate
- molybdate chrome orange
- nickel sulfate
- potassium permanganate
- silver nitrate
- sodium bisulfite
- sodium hydrosulfide
- sodium hydrosulfite
- sodium silicofluoride
- sodium thiosulfate
- sulfur dioxide
- zinc oxide
- zinc yellow

Based upon the levels of treatment costs measured in relation to selling price, the total dollar investment required for water treatment facilities, and the percent of the segment currently achieving B.P.T. and B.A.T. standards, it was apparent that some industry segments would not be impacted or would be impacted only minimally. The segments of the industry which were excluded from in-depth analysis as a result of this prescreening included the following:

Screeners criteria

- ammonium chloride
- ammonium hydroxide
- borax
- bromine
- chromic acid
- cuprous oxide
- ferrous sulfate
- fluorine
- hydrogen
- iodine
- lithium carbonate
- nitric acid (strong)
- nitrogen
- oxygen
- potassium chloride
- potassium iodide
- sodium fluoride
- stannic oxide
- zinc sulfate

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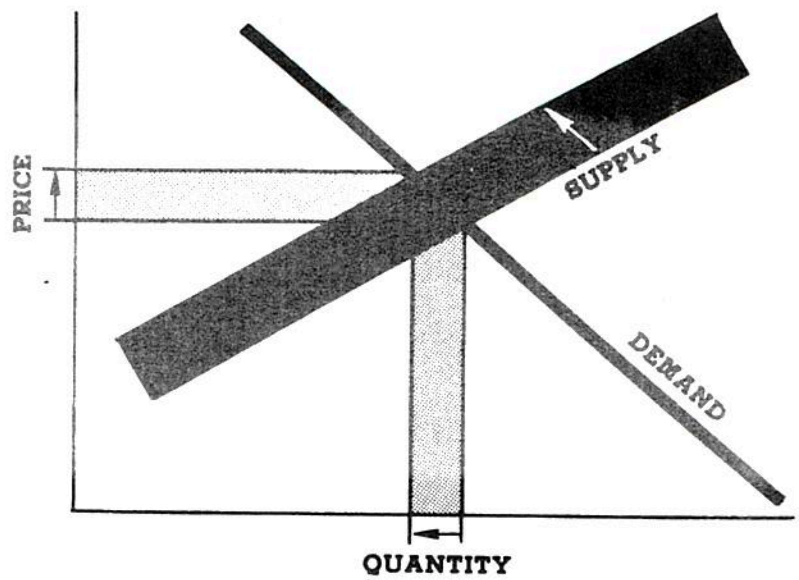
ECONOMIC ANALYSIS OF PROPOSED EFFLUENT GUIDELINES FOR THE INORGANIC CHEMICALS INDUSTRY PHASE II



U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Planning and Evaluation
Washington, D.C. 20460

B. PLANT SHUTDOWN FACTORS

If treatment costs cannot be passed on as price increases, the simplistic model says that the producer either absorbs them or shuts down his plant. The shutdown decision will involve both economic and strategic (i.e., noneconomic) considerations as follows.

Profitability--The after-tax cost per ton of water treatment compared with unit after-tax net income measures the producer's ability or willingness to absorb the added cost.

Cash Flow--Plants will continue to operate temporarily at essentially zero profitability (if necessary) if the plant is producing a positive cash flow (and has a competitive process and is in a stable or growing market).

Ratio of Investment in Treatment Facilities to Net Fixed Investment--If the new investment in water treatment facilities bulks large in comparison with existing plant investment (and other factors are marginal), a shutdown decision may be in order. In some instances, the availability (and cost) of capital to the producer may influence the shutdown decision.

Integration--The degree of backward or forward integration is a factor in the shutdown decision. A producer (or industry) with a significant raw material position or one using the product for downstream manufacture is less likely to curtail production than a non-integrated producer (or industry).

Chemical Complex--An isolated plant would be unable to take advantage of common treatment facilities.

Other Environmental Problems--If a plant has already committed funds for air pollution, it will be more likely to commit the additional funds necessary for water pollution. Alternately, if a company faces both water and air pollution abatement (and/or unusual OSHA) costs, the magnitude of the environmental and safety costs taken together may prompt a plant closing whereas any one taken alone would not.

Emotional Commitment--The emotional commitment of the company to that particular product (taking into account protection of competitive position, prestige, the importance of the product in the company's long-range strategy, etc.) may be a factor in the shutdown decision.

Ownership--Other things being equal (and negative), multi-industry companies are more likely to shut down marginal plants than less-diversified producers. The premise is that the multi-industry producer has other (and better) investment opportunities than the single product company (particularly a privately-held, family business).

IV. INDUSTRY CHARACTERIZATION

A. ALUMINUM FLUORIDE

1. Summary

In 1972, U.S. consumption of aluminum fluoride totaled 151,000 tons of which 139,000 tons were derived from domestic production and 12,000 tons were supplied by imports. U.S. output of aluminum fluoride, which is used almost entirely in the production of primary aluminum, has increased at an average annual compound rate of approximately 7% for the period 1963 through 1972. In its use as a fluxing agent for primary aluminum production, aluminum fluoride is to a minor extent interchangeable with another fluxing agent, cryolite. In general, however, there are no direct substitutes for aluminum fluoride in this major application. A very substantial part of aluminum fluoride consumption is captively supplied, viz. 64% in 1972.

There are currently four U.S. producers of aluminum fluoride, two of which--Aluminum Company of America and Kaiser Aluminum & Chemical--are also major aluminum producers. The two remaining aluminum fluoride producers, not integrated forward to aluminum production, are Allied Chemical and Stauffer Chemical. Productive capacity for aluminum fluoride has been in excess of actual production in recent years. In 1972 the industry operating rate was approximately 78%.

2. Market Characterization

a. Market Size and Growth

Department of Commerce data for aluminum fluoride production, foreign trade, and apparent consumption for the period 1963 to 1972 are shown in Table 4. During this time span U.S. production of aluminum fluoride has increased at an average annual compound rate of approximately 7.0% (assuming 1972 production was somewhat below the long-term trend line). If the estimated 12,000 tons of imported aluminum fluoride is added to the 138,800 tons of 1972 production, the apparent U.S. market for the material was somewhat over 150,000 tons. (The exact quantity of aluminum fluoride imports cannot be determined because the material is grouped with a number of other aluminum compounds in U.S. Tariff Commission import data.)

TABLE 4

PRODUCTION, FOREIGN TRADE, AND APPARENT CONSUMPTION OF ALUMINUM FLUORIDE

(Thousands of Tons)

Year	Production	Imports	Exports	Apparent Consumption
1963	81.4	NA	NA	NA
1964	92.6	NA	NA	NA
1965	111.9	NA	NA	NA
1966	124.8	NA	NA	NA
1967	131.6	NA	NA	NA
1968	139.0	NA	NA	NA
1969	143.1	NA	NA	NA
1970	135.7	NA	NA	NA
1971	157.9	NA	NA	NA
1972	138.8	12.0	NA	150.8

SOURCE: U.S. Department of Commerce.

b. Uses

Aside from minor applications in secondary aluminum production and use as a metallurgical and ceramic flux, aluminum fluoride is used entirely by producers of primary aluminum. In primary aluminum production, aluminum fluoride functions as a major make-up ingredient in the fused electrolyte of the aluminum reduction cell. Although there is no actual consumption of the aluminum fluoride in the electrolysis reaction, there are mechanical losses, pyrohydrolysis and some carbon tetrafluoride formation. Consumption varies between companies and smelters but averages between 60 to 70 pounds of aluminum fluoride per ton of aluminum produced. In addition to operating requirements (pot make-up), additional quantities of aluminum fluoride are needed for pot line start-up. A 65,000 ton pot line, for example, would require approximately 600 tons of aluminum fluoride as an initial charge.

The consumption of aluminum fluoride per ton of primary aluminum produced has declined in recent years as a result of the industry's efforts to realize more efficient recovery of fluorine values from pot linings and flue gases. Table 5 presents estimated consumption of aluminum fluoride in the U.S.

As previously mentioned, aluminum fluoride is also used in the refining of secondary aluminum. The two accepted techniques for producing secondary aluminum are referred to as "wet fluxing" and "hot fluxing." Aluminum fluoride is used in both wet and hot fluxing techniques to remove magnesium from the molten scrap, the actual quantity depending on the magnesium content of the scrap. Aluminum fluoride is also used in brazing fluxes (for aluminum fabrication), fluxes for ceramic glazes and enamels, and for welding rod coatings.

c. Substitute Products

In addition to aluminum fluoride, cryolite is also used as the molten electrolyte in the electrolytic reduction of alumina to aluminum metal. The two fluxes are to some degree interchangeable, depending upon operating practices and the sodium oxide content of the alumina used in the reduction plant. For start-up of a new pot line, considerably more cryolite is required (approximately 2,000 tons for a 65,000 ton pot line) than aluminum fluoride. During pot line operation, loss of fluorine values is greater than loss of sodium values. Consequently, during normal operation of a pot line, more aluminum fluoride than cryolite is used to maintain a constant composition of the melt. The effect of the industry's efforts to recover fluorine values from flue gases and pot linings will in general be more pronounced for cryolite than for aluminum fluoride.

d. Captive Requirements

Commerce Department data for the period 1968 through 1972 broken down by captive/merchant shipments are shown in Table 6. As indicated,

TABLE 5

U.S. CONSUMPTION OF ALUMINUM FLUORIDE

(Thousands of Tons)

	Primary Aluminum Production	Aluminum Fluoride Consumption		
		Primary Aluminum	Other	Total
1963	2,313	104	4	108
1965	2,755	111	4	115
1970	3,976	139	5	144
1972	4,122	144	6	150

SOURCE: Contractor estimates.